



Effect of Allostatic Load on Adverse Pregnancy Outcomes of Women in Late Pregnancy

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【Abstract】 Background The incidence of adverse pregnancy outcomes has remained high in recent years, which poses a serious threat to maternal and neonatal life and health. Chronic stress is known to be a risk factor for adverse pregnancy outcomes, while the relationship between allostatic load (AL) as a composite physiological index of chronic stress, and adverse pregnancy outcomes has not been clarified. **Objective** To explore the effect of AL on adverse pregnancy outcomes in women in late pregnancy. **Methods** Women in late pregnancy who met the study requirements were recruited as study subjects by using the convenience sampling method from November 2021 to November 2022 in the obstetrics outpatient clinics of the 901 Hospital, Joint Logistic Support Force of the Chinese People's Liberation Army, Jin'an Maternal and Child Health Care Hospital. Basic information such as general and obstetric data were collected through questionnaires, biological indicators were collected through physical examination and laboratory tests, and AL scores of the study subjects were calculated by referring to AL-related literature; pregnancy outcome information was obtained by reviewing the hospital electronic medical record system. Multivariate Logistic regression analysis was used to explore the effect of AL on adverse pregnancy outcomes in women in late pregnancy. **Results** A total of 354 women in late pregnancy with an average age of (29.3 ± 4.1) years and upper quartile of AL total score of 3 were included in this study. The upper quartile of the total AL score of the study subjects was used as the highrisk threshold, and they were divided into low-level AL ($AL < 3$) and high-level AL ($AL \geq 3$) according to their AL scores. High AL pregnant women accounted for 32.8% (116/354) and low AL pregnant women accounted for 67.2% (238/354). The prevalence of adverse pregnancy outcomes was 15.5% (55/354), including 9.9% (35/354) of macrosomia, followed by preterm birth (5.4% (19/354)) and low birth weight (2.3% (8/354)). The incidence of adverse pregnancy outcomes was higher in women in late pregnancy with high AL (26.7%, 31/116) than in women in late pregnancy with low AL (10.1%, 24/238) ($P < 0.05$); the incidence of preterm birth (10.3%, 12/116) and delivery of macrosomia (15.5%, 18/116) was higher in

women in late pregnancy with high AL than in women in late pregnancy with low AL (2.9%, 7/238; 7.1%, 17/238) ($P<0.05$). Multivariate Logistic regression analysis showed that women in late pregnancy with high AL had a 2.465-fold increased risk of adverse pregnancy outcomes compared to women in late pregnancy with low AL (95%CI (1.315, 4.622), $P<0.05$). High AL level was a risk factor for preterm birth ($OR=4.832$, 95%CI (1.545, 15.114)) and delivery of macrosomia ($OR=2.868$, 95%CI (1.392, 5.909)) in women in late pregnancy compared to low AL level ($P<0.05$). **Conclusion** High level of AL in women in late pregnancy increase the risk of adverse pregnancy outcomes, especially the risk of preterm birth and delivery of macrosomia. Attention to AL in women during pregnancy should be enhanced to provide a theoretical basis for preventing adverse pregnancy outcomes.

【Key words】 Pregnancy trimester, third; Allostatic load; Chronic stress; Adverse pregnancy outcome; Root cause analysis

Maternal and infant health is a top priority for national health, and adverse pregnancy outcomes are an important cause of harm to maternal and infant health. Adverse pregnancy outcomes mainly refer to a series of pregnancy complications and abnormal birth outcomes occurring during pregnancy that jeopardize the health of the mother and the fetus, such as preterm delivery, low birth mass, macrosomia, preeclampsia, birth defects, etc^[1]. Adverse pregnancy outcomes not only increase maternal and neonatal mortality, but also lead to neurodevelopmental problems in children (e.g., low IQ and cerebral palsy) ^[2], and increase the risk of obesity and diabetes mellitus in the offspring in adulthood^[3]. China has a large delivery base, and data from the National Health Commission show that in 2021, the number of hospitalized live births in China reached 10,515,000^[4]. The occurrence of adverse pregnancy outcomes reduces the quality of births, hinders the development of eugenics and imposes a huge economic burden on families and society. Numerous factors influence adverse pregnancy outcomes, and chronic psychosocial stress has been identified as a risk factor^[5]. Non-homeostatic load (AL) is a measure of chronic physiological stress, reflecting the accumulated wear and tear of the body's physiological systems under chronic stress^[6]. Currently, there are fewer foreign studies on AL and adverse pregnancy outcomes, and there are large differences in the results of these studies^[7], while there are still few relevant studies in China. The level of AL in late pregnancy represents the level of chronic stress accumulated by pregnant women throughout the gestation period. Therefore, the present study analyzes whether the level of AL in late pregnancy is a risk factor for adverse pregnancy outcomes, and provides a reference for strengthening the assessment of pregnancy risk and reducing the occurrence of adverse pregnancy outcomes.

1 Objects and Methods

1.1 Study subjects A prospective study design was adopted, and convenience sampling was used to select women in late pregnancy who were enrolled in the Department of Obstetrics and Gynecology, 901 Hospital, Joint Logistic Support Force of the Chinese People's Liberation Army, from November 2021 to November 2022, as the study subjects. Inclusion criteria: (1) natural conception, singleton; (2) 30-34 weeks of gestation; (3) clear thinking and normal expression; (4) informed consent. Exclusion criteria: (1) previous severe psychiatric and psychological disorders; (2) underlying diseases such as heart disease, hypertension, diabetes, hepatitis before pregnancy. Exclusion criteria: (1) incomplete completion of the questionnaire; (2) inability to follow up the pregnancy outcome. This study was reviewed by the Ethics Committee of Anhui Medical University (Ethics Approval Number:s20210076) .

1.2 Methods

1.2.1 Baseline survey

1.2.1.1 Questionnaire survey method (1) General information: including age, occupation, education level, annual per capita household income, history of vaccination with the vaccine, smoking and drinking during pregnancy (ever smoking is considered smoking, and drinking >15 g/d is considered drinking); (2) Obstetric information: number of deliveries, history of spontaneous abortion, history of obstetric and gynecological surgery (including history of cesarean section, laparoscopic surgery and hysteroscopic surgery); (3) depression in late pregnancy: the Edinburgh Postnatal Depression Scale (EPDS) was used to assess the depression status of women in late pregnancy.

The EPDS consists of 3 dimensions and 10 items, with higher scores indicating more severe depression^[8]. In this study, we used a score of 9 as the critical value recommended in the literature^[9], and a score of ≥ 9 was considered to have late-pregnancy depression. All investigators received uniform and strict training before the survey, and the questionnaire survey was conducted after obtaining the informed consent of the study participants and understanding the precautions for questionnaire completion, and the completeness of the questionnaire and key information were checked in time at the end of the survey.

1.2.1.2 Physical Examination (1) Height and Body Mass: Measured by an all-in-one height and body mass machine, with height and body mass readings accurate to 1 cm and 0.1 kg, respectively; (2) BMI: Calculated according to height and body mass; (3) Waist Circumference: A tape measure was taken along the level of the navel around the abdomen for a week, with readings accurate to 0.1 cm; (4) Blood pressure: Measured by a

Pulsatility electronic sphygmomanometer.

1.2.1.3 Laboratory examination Fasting was performed after 22:00 one day before the delivery, and fasting blood was collected from the laboratory of the hospital before 10:00 the next day (the subjects were fasting for at least 8 hours). All measurements were performed by the laboratory staff. Ultrasensitive C-reactive protein, fasting blood glucose, high-density lipoprotein and total cholesterol were measured using Beckman Coulter AU5800 and Hitachi 7600-020 automatic biochemical analyzers.

1.2.2 Follow-up of pregnancy outcomes Pregnancy outcomes are obtained by checking the hospital's electronic medical record system. Delivery information: delivery gestational week, mode of delivery, maternal health status and other information; newborn information: newborn birth mass, gender, length and health status and other information; adverse pregnancy outcomes: preterm labor, low birth mass, macrosomia. The primary study outcomes were adverse pregnancy outcomes (occurrence of preterm labor, low birth mass, and macrosomia).

1.2.3 AL evaluation At present, there is no uniform gold standard for AL evaluation methods [10]. Based on the relevant literature on AL [11-12], the following biomarkers were selected as the evaluation indexes of AL in women in late pregnancy: BMI, systolic blood pressure, diastolic blood pressure, waist circumference, total cholesterol, high-density lipoprotein, fasting blood glucose, and ultra-sensitive C-reactive protein. These 8 indicators represent the physiological changes in the cardiovascular system, metabolic system and immune system under chronic stress. AL scoring method: The high-risk quartile method [13] was used to score and classify the level of AL, in which the lower quartile of the HDL indicator was considered as high-risk, and the rest of the indicators were considered as high-risk in the upper quartile. The biomarker score in the high-risk quartile was counted as 1, otherwise it was counted as 0. Finally, the scores of each biomarker were summed up to get the total score, that is, the AL score, with a total score of 0-8, and the higher the score, the higher the health risk.

1.3 Statistical methods The data were double-checked and analyzed using SPSS 22.0 software. Measurement data conforming to normal distribution were expressed as ($\bar{x} \pm s$); measurement data were expressed as frequency and percentage; the chi-square test and Fisher's exact test were used for comparison between groups, and in order to prevent the omission of important independent variables, the level of the statistical two-sided test α was relaxed to 0.10. Variables that were statistically significant in one-way analyses were included in multifactorial Logistic regression analyses, and statistically significant differences were considered to have a significant difference with $P < 0.05$, which was considered to have a statistically significant difference.

2 Results

2.1 Baseline data of the study population A total of 354 women in late pregnancy, with a mean age of (29.3±4.1) years, and an upper quartile of total AL score of 3 were included in this study. The upper quartile of the total AL score was 3. In this study, the upper quartile of the total AL score was used as the high-risk threshold, and the subjects were categorized according to their AL scores into low-level AL (AL<3) and high-level AL (AL≥3). The percentage of pregnant women with high level AL was 32.8% (116/354) and 67.2% (238/354) with low level AL.

The average gestational week of delivery for the 354 study subjects was (38.9±1.3) weeks, and the mode of delivery included cesarean section and vaginal delivery, of which 137 (38.7%) were cesarean sections and 217 (61.3%) were vaginal deliveries. The incidence of adverse pregnancy outcomes was 15.5% (55/354), with a 9.9% (35/354) incidence of macrosomia, followed by preterm labor [5.4% (19/354)], low birth mass [2.3% (8/354)].

2.2 Comparison of the incidence of adverse pregnancy outcomes among women with different characteristics in late pregnancy The differences in the incidence of adverse pregnancy outcomes among women with different ages, history of spontaneous abortion, and gestational diabetes were statistically significant ($P<0.10$); the differences in the incidence of adverse pregnancy outcomes among women with different ages, educational levels, occupations, per capita annual household incomes, history of spontaneous abortion, gestational anemia, and gestational diabetes were statistically significant ($P<0.10$). There are statistically significant differences in the incidence of preterm labor among women with different levels of AL in late pregnancy ($P<0.10$); there are statistically significant differences in the incidence of low-birth-quality children among women with different levels of gestational anemia ($P<0.10$); and there are statistically significant differences in the incidence of macrosomia among women with different levels of gestational diabetes ($P<0.10$), as shown in Table 1.

Table 1 Analysis of adverse pregnancy outcomes in women in late pregnancy with different characteristics

Basic Characteristics	Cases	Adverse pregnancy outcomes	χ^2 value	P value	Preterm labor	χ^2 value	P value	Low birth mass	χ^2 value	P value	Macrosomia	χ^2 value	P value
Age			4.886	0.027		12.959	<0.001		2.535	0.111		0.001	0.978
<35	309	43 (13.9)			11 (3.6)			5 (1.6)			31 (10.0)		

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≥35	45	12 (26.7)			8 (17.8)			3 (6.7)			4 (8.9)		
Education level			1.387	0.500		5.365	0.068		2.152	0.341		0.382	0.826
Junior high school and below	72	12 (16.7)			5 (6.9)			2 (2.8)			6 (8.3)		
High School / Junior College	66	13 (19.7)			7 (10.6)			3 (4.5)			6 (9.1)		
College and above	216	30 (13.9)			7 (3.2)			3 (1.4)			23 (10.6)		
Occupation			0.569	0.753		5.321	0.070		3.583	0.167		0.697	0.706
Unemployed	63	8 (12.7)			1 (1.6)			1 (1.6)			7 (11.1)		
Service industry/individual	155	26 (16.8)			13 (8.4)			6 (3.9)			13 (8.4)		
Enterprises, institutions/technicians	136	21 (15.4)			5 (3.7)			1 (0.7)			15 (11.0)		
Per capita annual household income			5.878	0.118		6.814	0.078		5.538	0.136		1.060	0.787
<1	22	6 (27.3)			4 (18.2)			0			2 (9.1)		
1~<3	41	6 (14.6)			2 (4.9)			0			4 (9.8)		
3~<5	105	21 (20.0)			7 (6.7)			5 (4.8)			13 (12.4)		
≥5	186	22 (11.8)			6 (3.2)			3 (1.6)			16 (8.6)		
History of COVID-19 Vaccination			0.823	0.364		0.015	0.903		0.179	0.672		0.491	0.484
No	266	44 (16.5)			15 (5.6)			5 (1.9)			28 (10.5)		
Yes	88	11 (12.5)			4 (4.5)			3 (3.4)			7 (8.0)		
Smoking and drinking during pregnancy			1.199	0.274		0.392	0.531		—	1.000		0.189	0.664
No	333	54 (16.2)			19 (5.7)			8 (2.4)			34 (10.2)		
Yes	21	1 (4.8)			0			0			1 (4.8)		
Parity			0.568	0.451		0.151	0.698		0.068	0.794		1.073	0.300
First birth	183	31 (16.9)			9 (4.9)			5 (2.7)			21 (11.5)		
Multiparity	171	24 (14.0)			10 (5.8)			3 (1.8)			14 (8.2)		
History of spontaneous abortion			4.540	0.033		12.608	<0.001		1.464	0.226		0.069	0.793
No	298	41 (13.8)			10 (3.4)			5 (1.7)			30 (10.1)		
Yes	56	14 (25.0)			9 (16.1)			3 (5.4)			5 (8.9)		
History of surgery in obstetrics and			0.382	0.536		0.023	0.880		0.162	0.687		0.108	0.743

gynecology													
No	265	43 (16.2)			15 (5.7)			6 (2.3)			27 (10.2)		
Yes	89	12 (13.5)			4 (4.5)			2 (2.2)			8 (9.0)		
History of tocolysis in early pregnancy			1.209	0.272		1.501	0.221		0.907	0.341		0.070	0.792
No	289	42 (14.5)			13 (4.5)			5 (1.7)			28 (9.7)		
Yes	65	13 (20.0)			6 (9.2)			3 (4.6)			7 (10.8)		
Anemia in Pregnancy			0.318	0.573		5.194	0.023		3.183	0.074		0.802	0.370
No	218	32 (14.7)			7 (3.2)			2 (0.9)			24 (11.0)		
Yes	136	23 (16.9)			12 (8.8)			6 (4.4)			11 (8.1)		
Pregnancy-induced hypertension			0.062	0.803		0.190	0.663		—	0.375		0.136	0.713
No	334	52 (15.6)			17 (5.1)			7 (2.1)			34 (10.2)		
Yes	20	3 (15.0)			2 (10.0)			1 (5.0)			1 (5.0)		
Gestational diabetes mellitus			8.727	0.003		3.253	0.071		1.879	0.170		3.893	0.048
No	235	27 (11.5)			9 (3.8)			3 (1.3)			18 (7.7)		
Yes	119	28 (23.5)			10 (8.4)			5 (4.2)			17 (14.3)		
Kysthitis			0.018	0.894		0.547	0.460		—	1.000		0.008	0.928
No	330	52 (15.8)			19 (5.8)			8 (2.4)			32 (9.7)		
Yes	24	3 (12.5)			0			0			3 (12.5)		
Depression in the third trimester			2.571	0.109		0.463	0.496		2.093	0.148		1.731	0.188
No	274	38 (13.9)			13 (4.7)			4 (1.5)			24 (8.8)		
Yes	80	17 (21.3)			6 (7.5)			4 (5.0)			11 (13.8)		

2.3 Comparison of adverse pregnancy outcomes among women with different levels of AL gestation The incidence of adverse pregnancy outcomes among women with high levels of AL gestation is higher than that of women with low levels of AL gestation, and the difference is statistically significant ($P<0.05$) ; the incidence of preterm labor and the rate of delivery of macrosomia among women with high levels of AL gestation is higher than that of women with low levels of AL gestation, and the difference is statistically significant ($P<0.05$) ; there is no statistically significant difference in the incidence of low birth quality among women with different levels of AL in

late pregnancy ($P>0.05$), as shown in table 2.

Table 2 Comparison of adverse pregnancy outcomes in late pregnant women with different AL levels

Classification	Cases	Adverse pregnancy outcomes	Preterm labor	Low birth mass	Macrosomia
Low Level AL	238	24 (10.1)	7 (2.9)	3 (1.3)	17 (7.1)
High level AL	116	31 (26.7)	12 (10.3)	5 (4.3)	18 (15.5)
χ^2 value		16.456	8.417	2.049	6.139
		<0.001	0.004	0.152	0.013

2.4 Multivariate Logistic Regression Analysis of AL and Adverse Pregnancy Outcomes

2.4.1 Multivariate Logistic Regression Analysis of Adverse Pregnancy Outcomes in Women in Late Gestation

Whether adverse pregnancy outcome in the third trimester was used as the dependent variable (assignment: none =0, Occurrence =1), AL level (assignment: low level AL=0, High level of AL=1) and statistically significant variables in univariate analysis such as age (assigned: <35 years =0, 35 years old =1), history of spontaneous abortion (assignment: no =0, =1), gestational diabetes (assigned: no =0, With =1) was used as the independent variables, third trimester depression (assigned: no =0, Have =1) was also included as independent variables, a multivariate Logistic regression analysis was performed, the result showed that high levels of AL are a risk factor for adverse pregnancy outcomes in women in the third trimester, as shown in table 3.

Table 3 Multivariate Logistic regression analysis of influencing factors for adverse pregnancy outcomes in late pregnant women

Variable	<i>B</i>	<i>SE</i>	Wald χ^2 值	<i>P</i> value	<i>OR</i> value	95% <i>CI</i>
Age (with reference to <35 years)						
≥35	0.625	0.401	2.431	0.119	1.869	(0.852, 4.102)
History of spontaneous abortion (with none as a reference)						
With	0.510	0.371	1.889	0.169	1.666	(0.804, 3.451)
Gestational diabetes mellitus (with none as a reference)						

With	0.519	0.320	2.633	0.105	1.681	(0.898, 3.147)
Depression in late pregnancy (with none as a reference)						
With	0.456	0.344	1.758	0.185	1.578	(0.804, 3.096)
AL level (with low level AL as a reference)						
High level AL	0.902	0.321	7.913	0.005	2.465	(1.315, 4.622)

2.4.2 Multivariate Logistic Regression Analysis of AL and Three Adverse Pregnancy Outcomes Multivariate Logistic regression analysis was performed with preterm labor, low birth mass, and macrosomia as the dependent variables (assigned values: not occurring =0, occurring =1), and AL as the independent variable, and adjusted for some of the variables, and the results showed that, high levels of AL were a risk factor for preterm labor and delivery of a large child in women in late pregnancy compared with low levels of AL ($P<0.05$), as shown in table 4.

Table 4 Multivariate Logistic regression analysis of the association between AL and adverse pregnancy outcomes

Type of adverse pregnancy outcome	Dependent Variable	<i>B</i>	<i>SE</i>	Wald χ^2 value	<i>P</i> value	<i>OR</i> value	95% <i>CI</i>
Preterm labor ^a	High level AL	1.575	0.582	7.328	0.007	4.832	(1.545, 15.114)
Low birth mass ^b	High level AL	0.363	0.927	0.153	0.696	1.437	(0.234, 8.840)
Macrosomia ^c	High level AL	1.053	0.369	8.158	0.004	2.868	(1.392, 5.909)

Note: ^a indicates adjusted for age, education level, occupation, family income per capita, history of abortion, anemia during pregnancy, and gestational diabetes mellitus; ^b indicates adjusted for preterm birth and anemia during pregnancy; and ^c indicates adjusted for gestational age at delivery and gestational diabetes mellitus.

3 Discussion

With the continuous changes in fertility policy, population in China development will enter a critical turning period, eugenics and promoting long-term balanced population development have become the focus of maternal and child health care, but the occurrence of adverse pregnancy outcomes has seriously impeded this process. Chronic stress is known to be one of the risk factors for adverse pregnancy outcomes. In this study, we used AL as a measure of stress during pregnancy to investigate the effect of AL on adverse pregnancy outcomes in women in late pregnancy, with a view to reducing the incidence of adverse pregnancy outcomes and promoting the health of mothers and infants.

3.1 Incidence of adverse pregnancy outcomes A total of 354 cases of women in late pregnancy were included in this study, and the incidence rate of adverse pregnancy outcomes was 15.5%, which was lower than the 19.77% in

the study by Wang Dan^[14] and the 21.6% in the study by Yang Xiaowu^[15], which may be mainly due to the fact that the target population of this investigation was women in late pregnancy, and the types of adverse pregnancy outcomes didn't include early miscarriage. The incidence of macrosomia in this study was 9.9%, slightly higher than the 8.7% incidence of macrosomia reported in the study^[16], which may be related to the improvement of material living standards and overnutrition during pregnancy. Preterm labor is a global public health problem and a major cause of neonatal mortality.

According to data reported by the World Health Organization, about 15 million preterm babies are born globally each year, with a prevalence rate of 10%, and it is still increasing^[17]. A research team in China used data from the National Maternal Event Surveillance System to reveal that the overall preterm birth rate in China rose from 5.9% in 2012 to 6.4% in 2018^[18], and preterm birth remains a problem that cannot be ignored. Low birth body mass often occurs in conjunction with preterm labor, which is not only one of the leading causes of infant mortality, but also carries a higher risk of developmental delay in childhood and long-term stunting^[19].

The incidence of low birth quality in China has increased from 2.64% in 2015 to 3.7% in 2021^[4], showing a rising trend year by year. The incidence of adverse pregnancy outcomes is high and harmful, which reduces the quality of the birth population and hinders the development of eugenics. With the landing and implementation of the three-child policy, the group of high-risk pregnant women will continue to expand in the future, greatly increasing the risk of adverse pregnancy outcomes. Therefore, it is crucial to pay attention to the risk assessment of adverse pregnancy outcomes to provide a scientific basis for preventing the occurrence of adverse pregnancy outcomes.

3.2 AL and adverse pregnancy outcomes In this study, there were 116 pregnant women with high levels of AL among 354 women in late pregnancy, accounting for 32.8%. Univariate analysis showed that the incidence of adverse pregnancy outcomes in women with high levels of AL was significantly higher than that in women with low levels of AL; Multivariate logistic regression analysis showed that AL was a risk factor for preterm labor and macrosomia, and high levels of AL would increase the incidence of adverse pregnancy outcomes. Multivariate logistic regression analysis showed that AL was a risk factor for preterm labor and macrosomia, and that high levels of AL increased the risk of adverse pregnancy outcomes, which was consistent with the results of a study by Lueth et al^[7]. The occurrence of adverse pregnancy outcomes is the result of a combination of risk factors, but the pathophysiologic mechanisms leading to these adverse pregnancy outcomes are still uncertain, and cumulative stress may be an influential factor^[6]. Pregnancy is a stressful process, and pregnant women face different stressors at different times of pregnancy, and face different stress loads. Women in late pregnancy not only suffer from the stress accumulated in early and mid-

pregnancy, but also face the stress associated with late pregnancy, and the level of late-gestational AL represents the level of chronic stress that accumulates in a pregnant woman throughout the gestation period. In addition, the physiological load of pregnant women increases continuously during pregnancy and reaches its peak in late pregnancy, so the physiological and psychological loads of women in late pregnancy are at a high level. When the accumulated load exceeds the body's ability to cope, it causes dysfunction of several physiological systems and high levels of AL. Since conception and pregnancy require a complex series of neurological, endocrine, immune, and metabolic changes to maintain them, the course of pregnancy may be altered when these physiological systems become dysfunctional.

The present study found that high levels of AL in late pregnancy increase the risk of preterm labor, the etiology as well as the pathogenesis of preterm labor is complex, and it has been shown that maternal stress and stress-related reactions during pregnancy increase the overall risk of preterm labor^[20]. Stress activates the maternal inflammatory system, which increases the level of inflammatory system stress, leading to high levels of AL in the body; inflammatory markers also suppress the immune system response, increasing susceptibility to adverse pregnancy outcomes, which may ultimately induce preterm labor. Studies have shown that adverse stress during pregnancy increases the risk of preterm labor and low birth quality^[21], and there is a significant association between elevated AL and shorter gestation^[22]. A secondary analysis of a multicenter randomized clinical trial found that increased AL scores were associated with an increased probability of preterm labor and low birth quality^[11]. In addition, stress in women during pregnancy may affect physiologic stress, risk of preterm labor, and birth outcomes over multiple generations, and factors determining the risk of preterm labor may be passed on to offspring through the maternal line, including cumulative stress^[23].

The results of this study suggest that high level of AL in women in late pregnancy is a risk factor for the development of macrosomia, and the risk of macrosomia in women in late pregnancy with high levels of AL is 2.868 times higher than that with low levels of AL. The occurrence of macrosomia is closely related to maternal blood glucose and lipid levels^[24], and maternal blood glucose and lipid levels depend on the regulation of various physiological systems of the body, especially the metabolic system, and AL contains a number of physiological indicators of the metabolic system, which can reflect the physiological function of the metabolic system in a more comprehensive manner. With the rapid development of economy and the rising concern for nutrition during pregnancy, macrosomia will remain a serious problem in the coming years, and close attention should be paid to fetal growth and development during pregnancy, and interventions such as personalized dietary guidance and exercise plans should be formulated for women during pregnancy to alleviate the physiological and psychological stress of pregnant

women through the provision of professional guidance and to achieve early detection and early prevention.

In conclusion, the results of this study show that high levels of AL in women in late pregnancy increase the risk of preterm labor and macrosomia, and that AL, as a comprehensive physiological indicator of chronic stress, is able to assess the functional response to chronic stress in a more comprehensive way. High levels of AL in women in late pregnancy reflect the dysfunction of multiple physiological systems caused by the cumulative stress load during pregnancy, and the process of pregnancy to labor requires a series of normal physiological activities to maintain, therefore, when the level of AL is elevated, the dysfunction of multiple physiological systems may affect the process of pregnancy and lead to the occurrence of adverse pregnancy outcomes. However, only three types of adverse pregnancy outcomes were included in this study. In the future, more large-sample, prospective cohort studies should be conducted to include as many types of adverse pregnancy outcomes as possible, so as to further investigate the association between AL and adverse pregnancy outcomes in pregnant women and the potential mechanisms.

Authors' contributions: Wang Minghuan and Yuan Dehui were responsible for recruiting the study participants and data collection, managing and analyzing the data; Wang Minghuan wrote the paper; Yu Min and Wang Yougang were responsible for organizing the site and coordinating the project; Yu Qiaozhi, Yang Fangfang, and Zhang Liu were involved in data collection; and Li Yuhong was responsible for the overall design of the study, organizing the project, quality control, and proofreading the article.

There is no conflict of interest in this article.

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